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IRD Mechanalysis

MODEL 820
Vibration/ Spike Energy Analyzer

Workbook

IRD Mechanalysis

MODEL 820
Vibration/ Spike Energy Analyzer

Workbook

Model 820 Part Numbers:

Complete Training Program	29997
Slide/Tapes	29994
Workbook	29995
Instructor's Guide	29996

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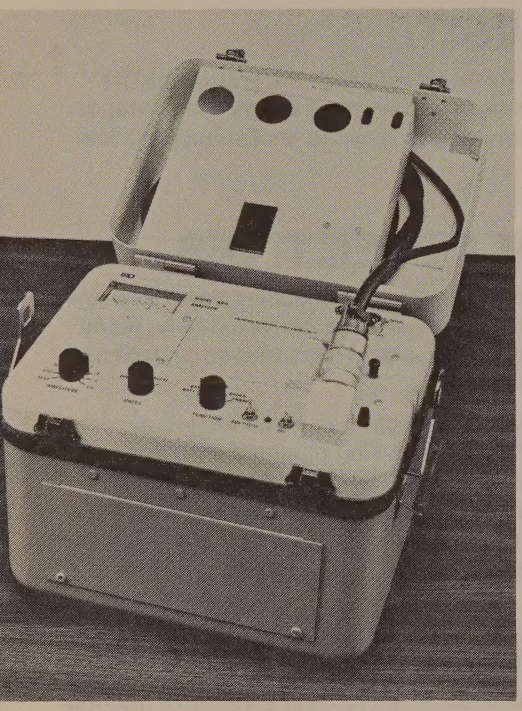

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PREREQUISITE

As a prerequisite to this training program, you should be familiar with the basics of vibration predictive maintenance programs. This information is provided in Training Module PMP-1.

PROGRAM OBJECTIVES

Rotating machines that are properly installed and maintained will give years of trouble-free service. Unfortunately, many machines develop mechanical problems that go undetected until a serious failure occurs.

The Model 820 has been developed to make the job of measuring, recording and analyzing machine vibration easier. Individuals completing this training program will develop an understanding of the features and operation of the Model 820 and how to use this instrument in a predictive maintenance program.

PERFORMANCE OBJECTIVES

1. By viewing the slide/tapes, answering a series of multiple choice questions, and performing hands-on exercises, you will be able to:
   - Identify the features and capabilities of the Model 820.
   - Use the Model 820 to record data and diagnose machine problems.
2. Given a familiarity for the Model 820, you will be able to:
   - Determine a machine's mechanical condition by vibration measurements and analysis.
   - Produce printouts of machine vibration spectra.

MATERIALS REQUIRED

Model 820 Vibration/Spike Energy Analyzer
Model 970 Accelerometer
Pickup Cable
Chart Paper
9-inch Probe
Battery Charger
Model 820 Slide/Tapes
  Part 1
  Part 2
Model 820 Workbook
Machine suitable for taking practice measurements
Kodak Carousel® projector, cassette recorder and screen
  OR
Automatically synchronized slide/tape viewer
Optional Accessories may be used as necessary

BEFORE STUDYING THIS TRAINING PROGRAM

Before beginning this training program, have all the materials and equipment close at hand.

Learn how to operate your audio-visual equipment. For your convenience the slides have been loaded into Carousel trays, and two cassettes are supplied for each tray.

One tape, marked **MANUAL,** can be played on any standard cassette tape recorder. It has audible tones which signal you to advance the projector to the next slide.

The other cassette in each box, labeled **AUTOMATIC,** is for use on equipment having automatic sync capabilities. The tape has a 1000Hz sync pulse that will automatically advance the projector.

For each program, load the slide tray, advance it to the first slide, and focus **before** turning on the recorder.

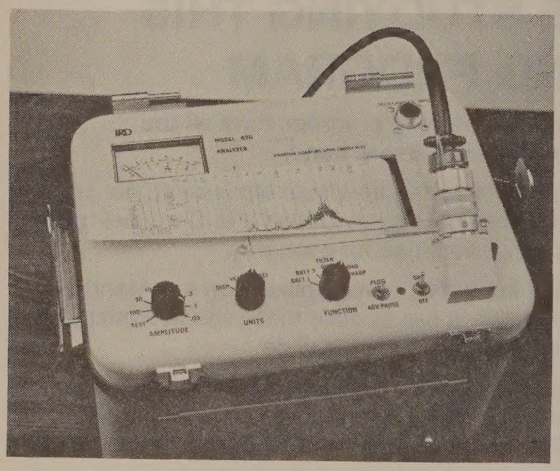
HOW TO STUDY THIS PROGRAM

Part 1

1. View the Slide/Tape for Part 1.
2. Complete the Part 1 Exercises found in the back of this workbook. The exercises have been developed to help you evaluate your understanding of the material covered.
3. Check your answers with the list on Page .
4. Review the information about the questions you answered incorrectly. You may repeat specific sections of the slide/tape program, or review the information in this workbook.
5. Complete the Hands-On Exercises for Part 1.

Part 2

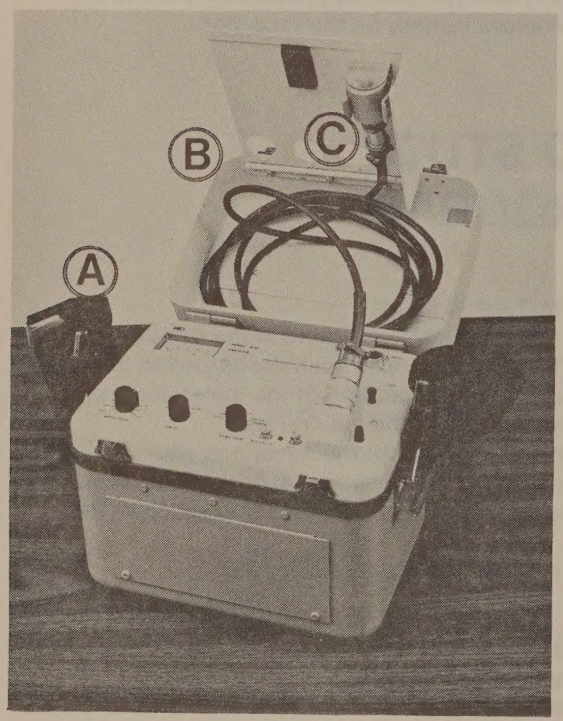
6. View the Slide/Tape for Part 2.
7. Complete the Part 2 Exercises.
8. Check your answers and review information as necessary.
9. Complete the Hands-On Exercises for Part 2.



INTRODUCING THE MODEL 820

The Model 820 is a portable, microprocessor-controlled unit, designed to provide fast, narrow-band vibration analysis of all types of rotating equipment.

The fully automatic printer on the 820 provides Amplitude vs. Frequency plots, Amplitude vs. Time plots, Spike Energy vs. Time plots, and RPM printouts. With the appropriate accessories, it can also be used to obtain sound measurements.



FEATURES

The Model 820 has several key features enabling users to collect data in a rapid, concise manner.

Ⓐ **CARRYING STRAP**—permits freedom of movement by the user and may be easily removed by disconnecting the buckles.

Ⓑ **LID**—slides off the base; stores 970 Accelerometer, and cable.

Ⓒ **970 ACCELEROMETER** and 12-foot pickup cable—standard pickup and cable supplied with the 820; may be left connected to the input receptacle.

Ⓓ **INPUT RECEPTACLE**—accepts the standard 970 Accelerometer, as well as the Model 544 Velocity Pickup, non-contact signal sensors, and the Model 308 Vibration/Sound Level Meter.

NOTE: Each pickup used with the 820 must be connected with the appropriate cable as listed in the Model 820 Operator's Manual.

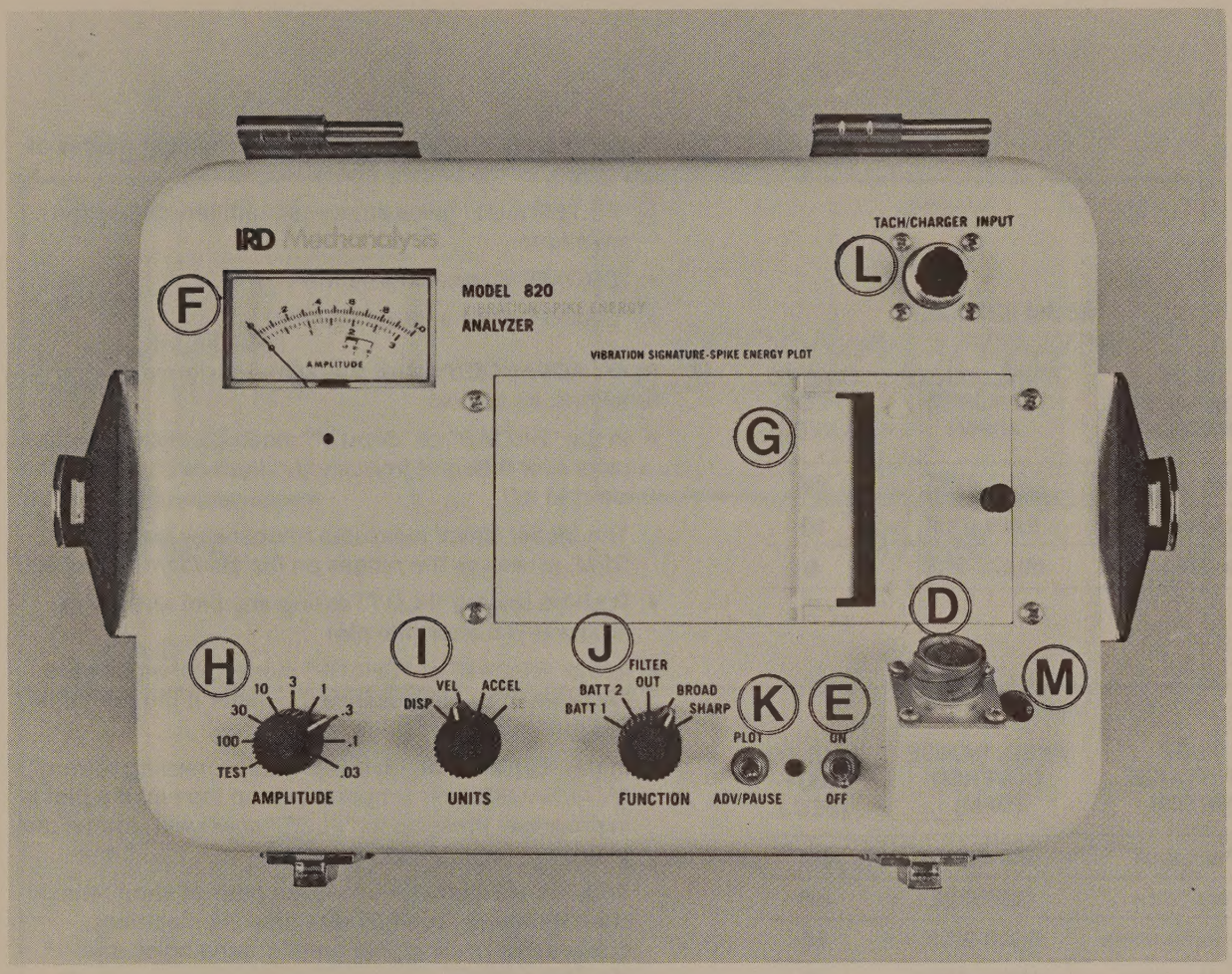
Ⓔ **ON/OFF SWITCH**—connects the battery power supply.

Ⓕ **AMPLITUDE METER**—displays the overall vibration level of the machine being measured; indicates the condition of the internal batteries.

Ⓖ **PRINTER**—produces hard-copy vibration or noise spectrum plots; prints test signal.

Ⓗ **AMPLITUDE SWITCH**—selects the full-scale range of the amplitude meter and printer, or the "TEST" mode.

The 100, 10, 1 or .1 position corresponds to the 0 to 1 scale on the amplitude meter. The 30, 3, .3 or .03 corresponds to the 0 to 3 scale.



Ⓘ **UNITS SWITCH**—selects the vibration parameter, either "DISPLACEMENT, VELOCITY, ACCELERATION," or the unique "SPIKE ENERGY" measurement for determining the condition of rolling bearings.

Amplitude readouts will be printed in the units shown.

	Model 820 ENGLISH	Model 820M METRIC
Displacement	mils	micrometers
Velocity	in/sec	mm/sec
Acceleration	g	g
Spike Energy	gSE	gSE

Model 820/820M

PLOT ADV/PAUSE SWITCH	FREQ. RANGE COVERED (CPM)	TIME TO PLOT (SEC.)
Press once	600-600K	36
Press twice	6,000-600K	16
Press three times	60,000-600K	6

Model 820LF

PLOT ADV/PAUSE SWITCH	FREQ. RANGE COVERED (CPM)	TIME TO PLOT (SEC.)
Press once	180-600K	95
Press twice	600-600K	36
Press three times	6,000-600K	16
Press four times	60,000-600K	6

Ⓙ **FUNCTION SWITCH**—selects one of the filter modes of operation, or the battery check modes.

- "FILTER OUT" gives an overall, unfiltered vibration amplitude.
- "BROAD" gives a 10% bandwidth.
- "SHARP" gives a 5% bandwidth.

Ⓚ **PLOT ADVANCE/PAUSE SWITCH**—performs several functions, as follows:

- In the "BROAD" or "SHARP" mode it obtains spectrum plots over different frequency ranges as shown on the chart at left.

  The Model 820LF measures frequencies below 600 CPM, as well as the ranges on the standard Model 820.
- Pushing toward "PLOT" during any plot already in progress will abort the plot.
- In the "BROAD" or "SHARP" mode, pushing toward "ADV/PAUSE" will advance the paper if the printer is not running.
- In the "BROAD" or "SHARP" mode, pressing toward "ADV/PAUSE" will temporarily stop the plot if a plot is in progress. Pressing to "PLOT" again will resume the plot.

  This feature allows you to make plots of short, steady-state vibrations, such as wire drawing machines, compressor cycling phenomena, mine hoist, and elevator motion.

Ⓛ **TACH/CHARGER INPUT**—attaches to speed reference pickup cables to provide machine RPM printouts; connects to battery charger.

Ⓜ **INTERLOCK SWITCH**—automatically turns off power when lid is closed.

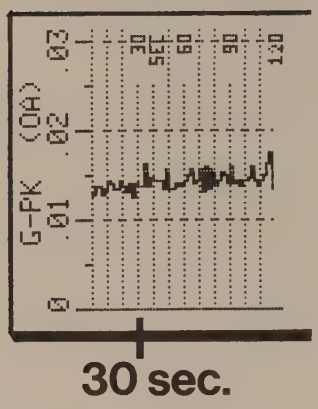
These features are located inside the front panel on the 820:

BATTERY PACK—rechargeable, lead-acid battery operates for approximately ten hours without recharging.

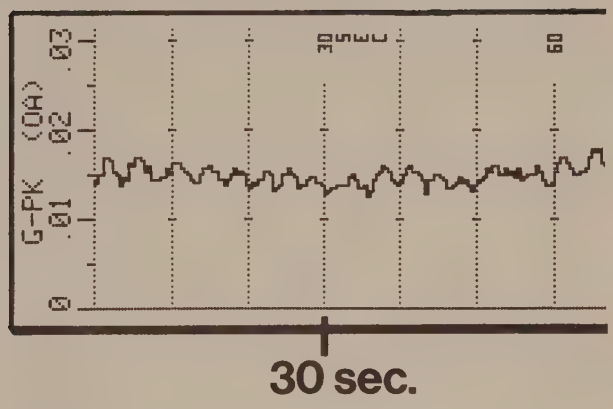
FUSES—½amp fuse protects the analyzer circuits. 2amp fuse protects the printer.

A **CHART SPEED SWITCH** located under the chart paper cover allows you to select "FAST," "MEDIUM" or "SLOW" speed on Time Plots.

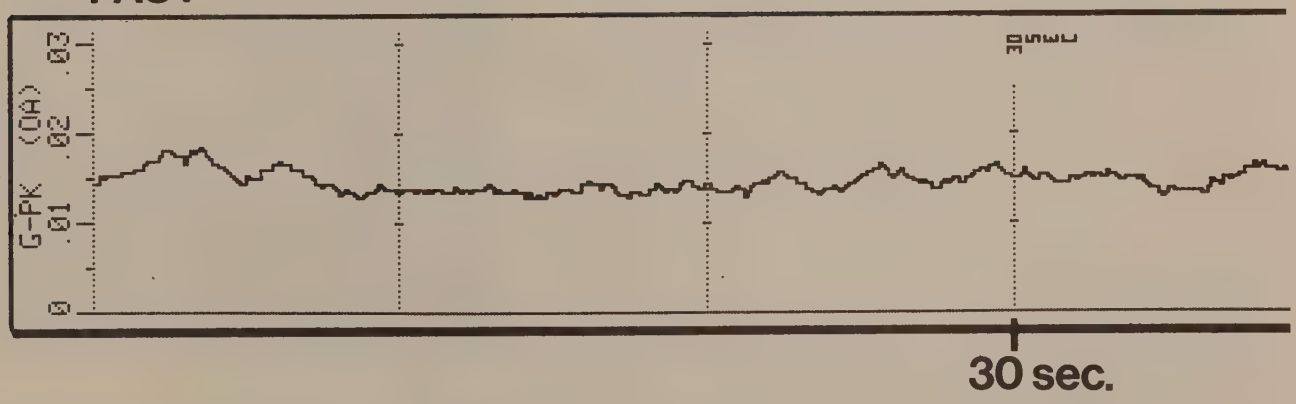
SLOW



MEDIUM



FAST



STANDARD ACCESSORIES

The IRD Model 820 comes equipped with these standard items:

- Carrying Case
- Model 970 Accelerometer
- 12-foot Pickup Cable
- 9-inch Probe
- Model 426 Battery Charger
- 6 Rolls Chart Paper
- Operator's Manual

OPTIONAL ACCESSORIES

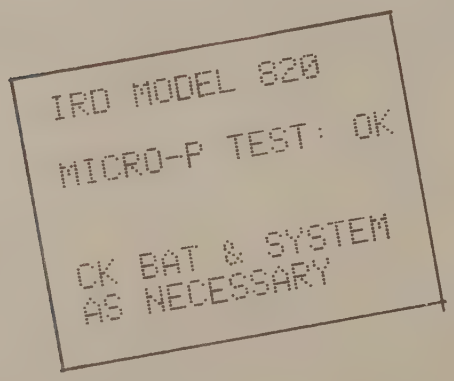
The following optional items are available to increase the versatility and usefulness of the Model 820.

- Model 544 Velocity Pickup and Cable
- Extension Cables
- Magnetic Holder
- Photoelectric Reference Pickup
- Electromagnetic Reference Pickup
- Mounting Fixtures
- Model 308 Vibration/Sound Level Meter
- IRD Calibrator—for checking the Velocity and Acceleration modes of the Model 820.
- Spare Battery Pack
- Battery Pack Charger Adapter

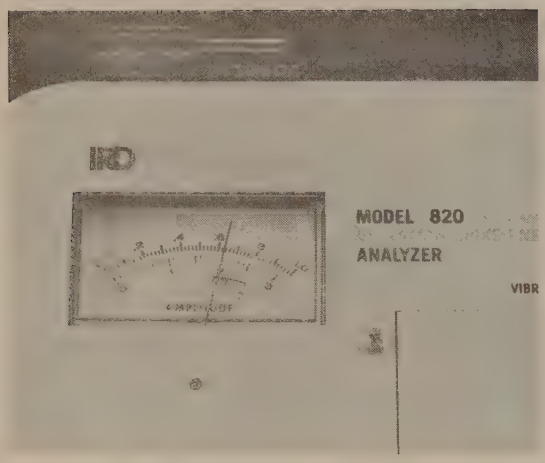
TESTING THE MODEL 820

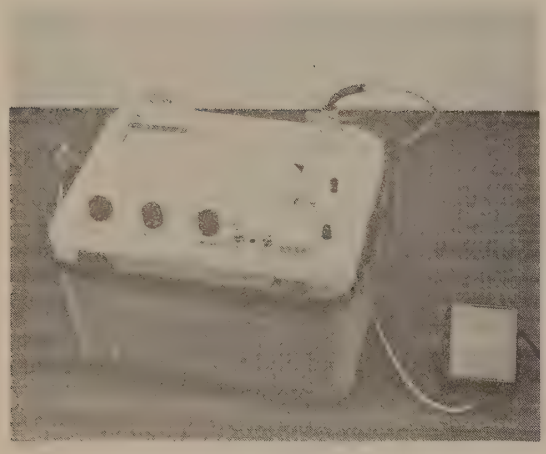
Before using the 820 in the field, set it up and run a test of the circuits.

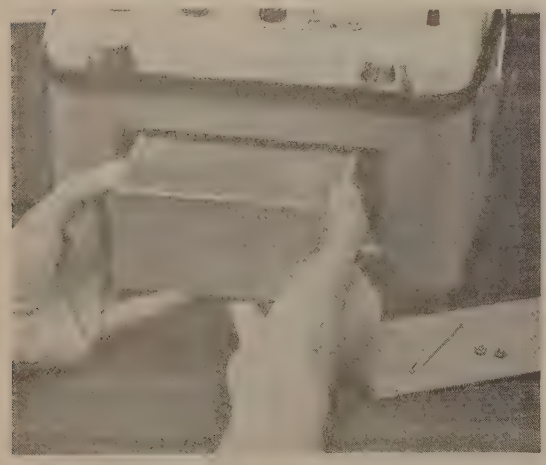
1. Open the case and slide off the lid.
2. Turn "on" the power.
   The 820 will run through a series of self-checks and, if operating correctly, the printer will provide this message:



3. Check the red LED.
   When the power is turned "on", the LED will light, indicating the automatic check cycle is in progress. After about six seconds the light will start blinking. The blinking light will continuously remind you that the power is "on".







If the red light **does not come on,** there is a defect in the unit, such as a burned out bulb or no battery power. Correct these faults before using the Model 820.

If the red light **does not blink** after about six seconds, there is a problem with the microprocessor and the unit should be returned to an authorized service center.

4. Check the two batteries.
   - Set the FUNCTION switch at "BATT 1." Read the position of the needle in the Amplitude Meter. It should register near the "HI-1" position.
   - Set the FUNCTION switch at "BATT-2." The needle should register near the "HI-2" position.
5. If necessary, recharge the batteries. If either of the batteries registers "LO", recharge the batteries with the charger, or replace with a fully-charged, spare battery pack.

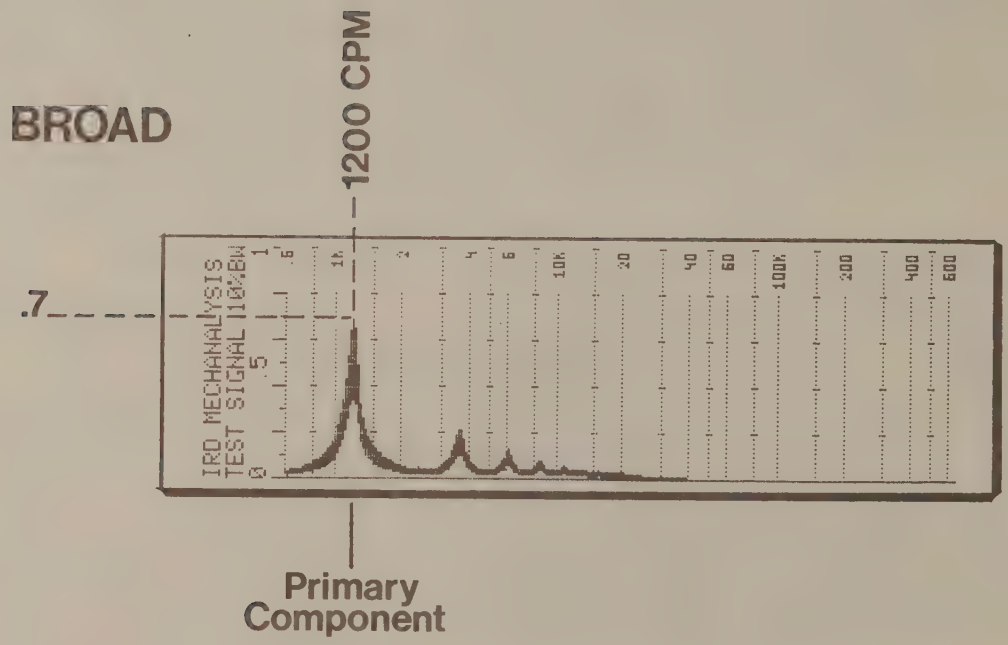
   To recharge the batteries:
   - Set the switch on the battery charger to match the voltage being supplied, either 110 or 220 volts, AC, 50 to 400 Hz.
   - Do not attempt to recharge the Model 820 with any other charger than the Model 426 provided.
   - Connect the battery charger cable to the TACH/CHARGER INPUT.
   - Plug the power cord into a wall receptacle.

   Recharging the batteries takes 8 to 12 hours. During this time, do not turn on the 820. A built-in circuit prevents overcharging.

   A fully-charged battery will operate for approximately ten hours, or the equivalent of 700 Broad or 250 Sharp signatures. To make the Model 820 continuously operational, a spare battery pack may be used.

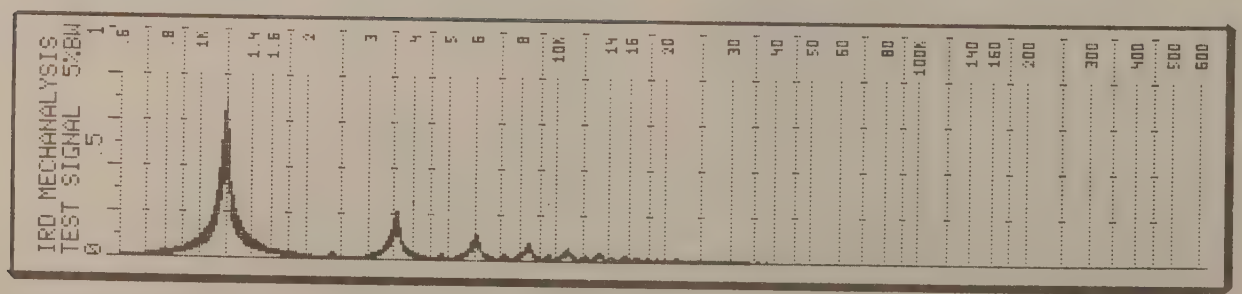
   To replace the battery pack:
   - Remove the two screws on the front panel and lift it off.
   - Remove the screw on the left side of the battery pack.
   - Slide out the low battery and slide in a fully-charged spare.
   - Replace the screws and cover plate.
6. Print a vibration signature of the test signal.
   - Set the AMPLITUDE switch to "TEST".
   - Set the UNITS switch to "DISPLACEMENT, VELOCITY," or "ACCELERATION."
   - Set the FUNCTION switch to "BROAD."

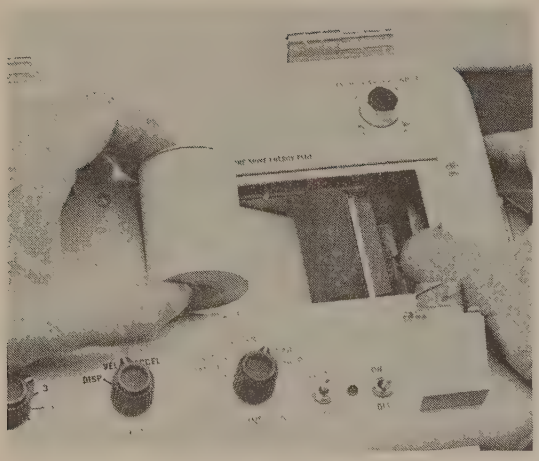
- Check the upper scale on the Amplitude Meter. The needle should register between .75 and .85.
- To initiate the plot, momentarily push the PLOT ADV/PAUSE switch to "PLOT" and release.
- When finished printing (approximately 36 sec.), check the printed plot. It should resemble this Broad Test Signal.



SHARP

- In the "SHARP" filter position a test signal similar to this should be generated.



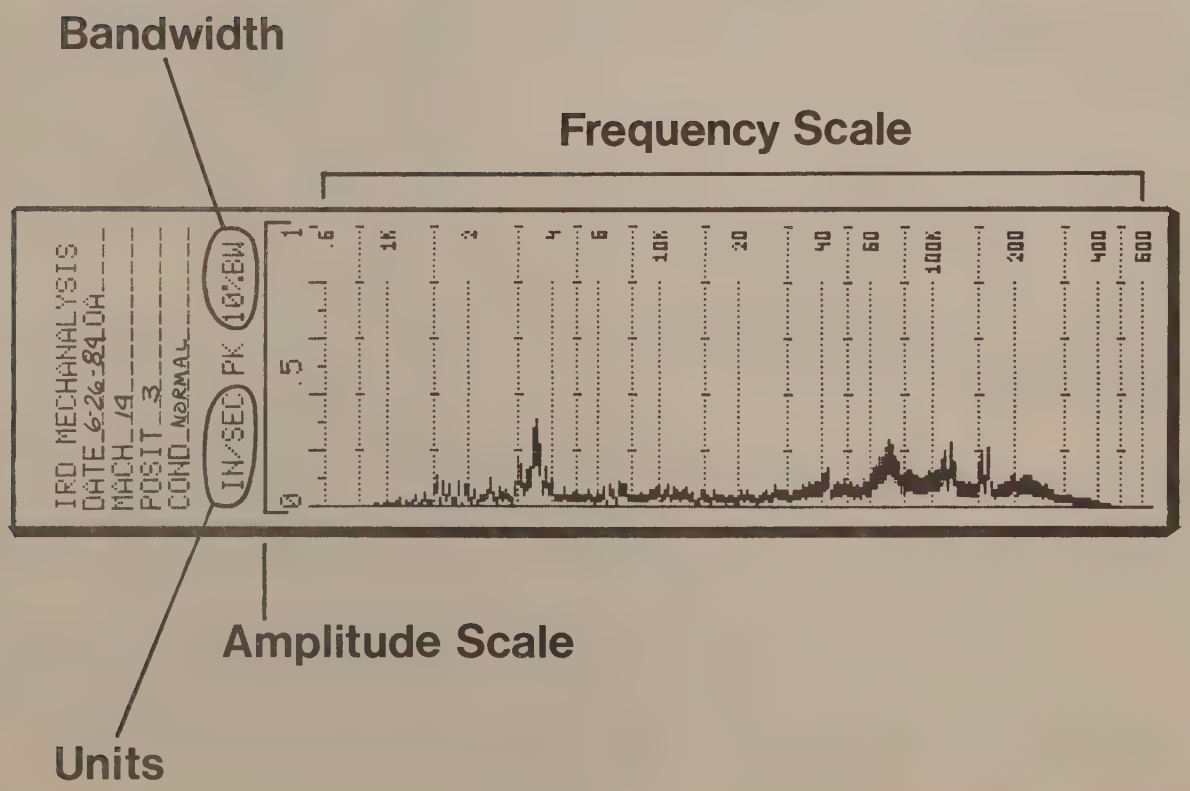


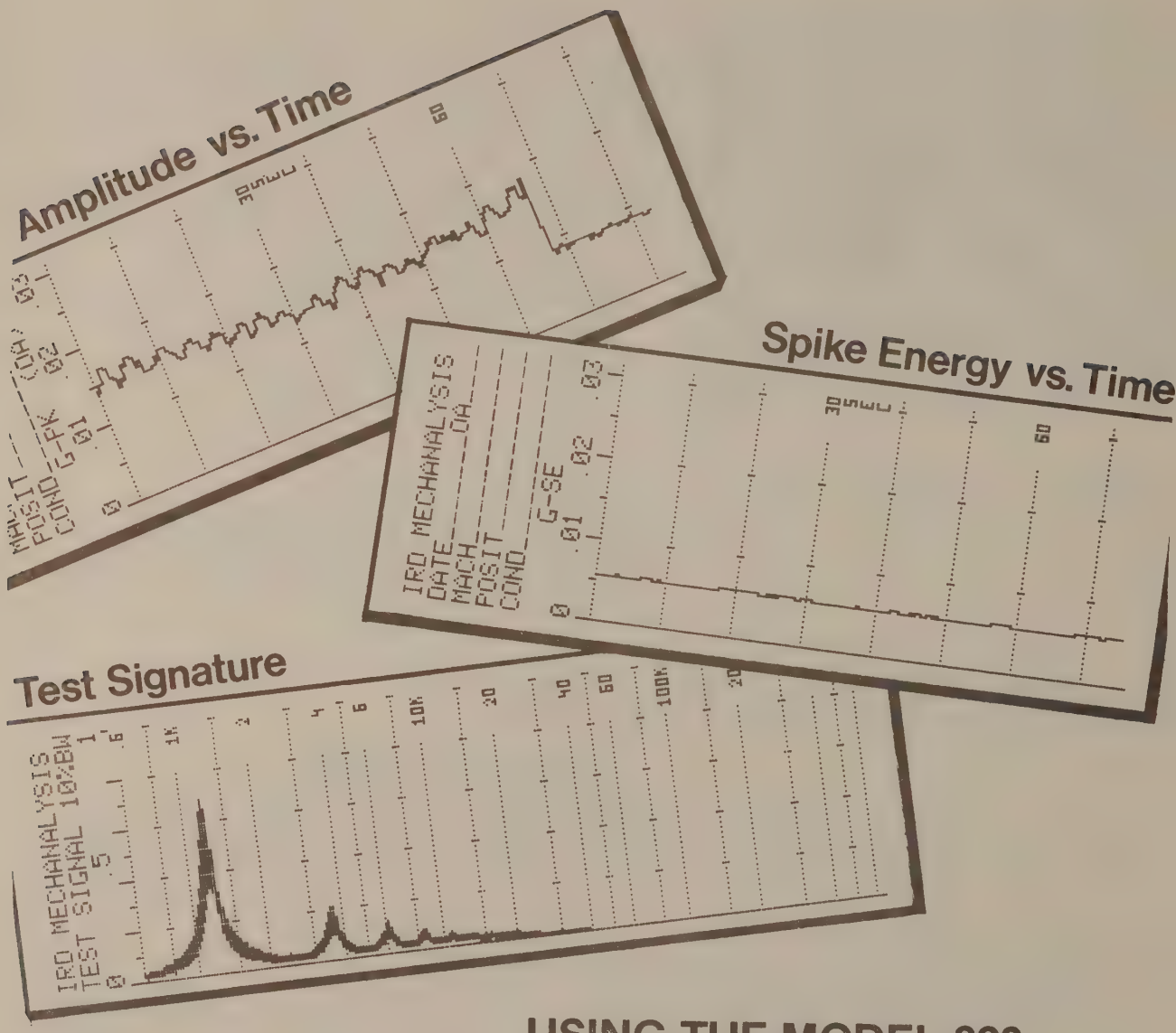
7. Check paper.

   A red line along the edge of the chart paper indicates the paper is getting low. To install a new roll:

   - Loosen the thumb screw and remove the printer cover plate.
   - Take out the old roll and load a new one on the spindle. Paper should unroll from under the roll to the right.
   - Press the spring-loaded printhead away from the roller and feed paper under the roller.
   - Roll out some extra paper by hand-turning the roller and slip it through the slot on the cover plate.
   - Replace cover.

The printouts produced by the Model 820 show the engineering units, the filter bandwidth setting, and the amplitude and frequency scales. The printouts also have a space for noting machine information.



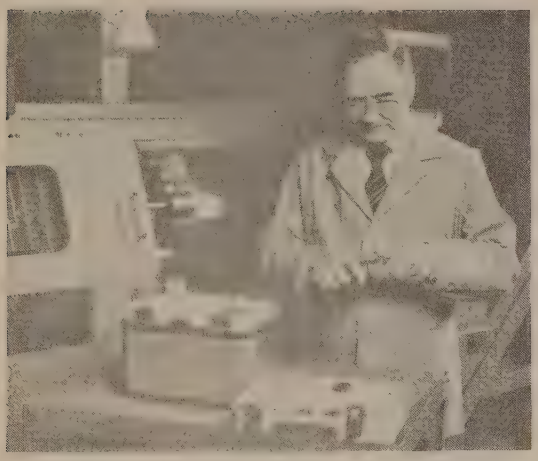


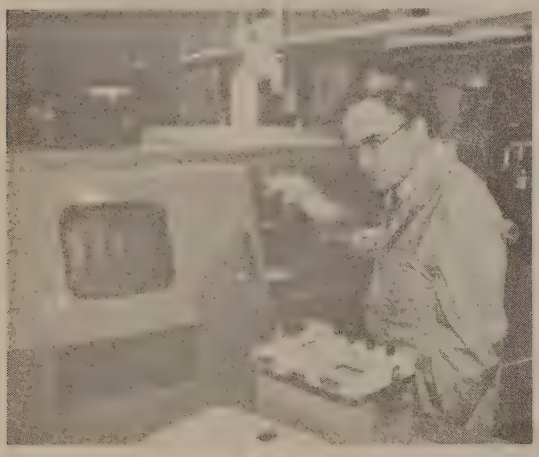
USING THE MODEL 820

The most common use of the Model 820 is to acquire machinery vibration signatures using the 970 Accelerometer. Attach the 970 to the cable using the threaded connector and attach the other end of the cable into the input receptacle on the top of the Model 820.

The Model 544 Velocity Pickup may also be used with the Model 820. Attach the pickup and cable in the same manner as the 970, using the Velocity Pickup Cable.

NOTE: Each pickup used with the Model 820 must be attached with the appropriate cable, as listed in the Operator's Manual.



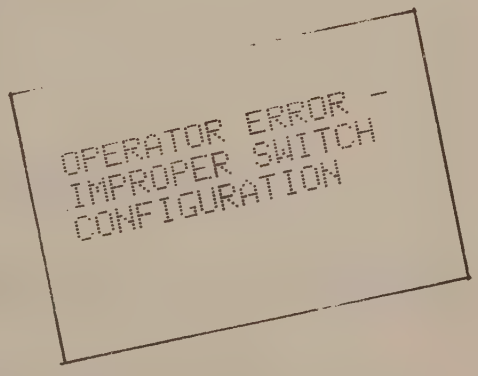


AMPLITUDE vs. FREQUENCY PLOTS

Follow these steps to obtain an Amplitude vs. Frequency Plot:

1. Attach the pickup to the machine being measured by using a magnetic holder, the hand-held 9-inch probe, or attach with a one-quarter twenty-eight stud.
2. Set the UNITS switch to "VELOCITY," or "ACCELERATION." A vibration signature cannot be obtained in the "Spike Energy" mode.
3. Set the FUNCTION switch to "BROAD" or "SHARP." For most applications the "BROAD" filter will provide adequate frequency resolution. However, when a more detailed frequency spectrum is required, use the "SHARP" filter.
4. Adjust the AMPLITUDE switch until the needle in the Amplitude Meter registers between one-third of full scale and full scale.
5. Initiate the signature plot by pressing the PLOT/ADV PAUSE switch to "PLOT", and then releasing it.

   This message means an improper Function or Unit has been requested.



- "DISPLACEMENT" cannot be obtained when a Model 970 Accelerometer is being used.
- "ACCELERATION" cannot be obtained when a Model 544 Velocity Pickup is being used.
- A vibration signature cannot be obtained in the "SPIKE ENERGY" or "BATTERY" modes.

6. To achieve "DISPLACEMENT," use a Model 544 pickup.

A vibration spectrum generated by the Model 820 steps the requested filter across the frequency in small increments. At each frequency increment the filtered amplitude is sampled and plotted as a line on the frequency axis of the chart.

The printed plots have continuous, parallel frequency lines:

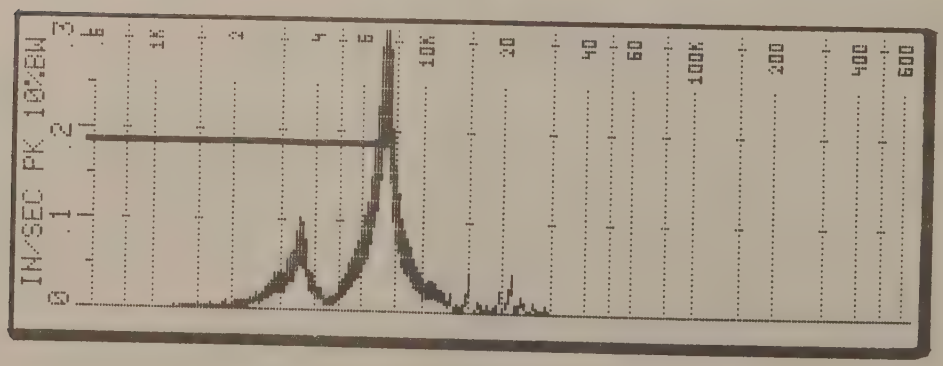
- 264 lines in the "BROAD" position, taking about 36 seconds to print.
- 430 lines in the "SHARP" position, taking about 93 seconds to print.

Satisfactory amplitude resolution can generally be obtained when the amplitude needle registers between one-third of full scale and full scale on the Amplitude Meter. However, to obtain better resolution, the AMPLITUDE switch may be moved to the next more sensitive range. Adjusting the scale will increase one or more of the larger peaks **over** scale (off the chart paper).

As long as the largest amplitude peak is not more than 60% of full scale, the amplitude of the highest peak can still be accurately determined. Multiply the amplitude of the **low** end of the peak by two. For example, if the low end of the peak line is .18, the amplitude is .36.

Over scale amplitude:

.18 x 2 = .36 in/sec



FREQUENCY CALCULATION TABLE

Number of Lines Above Frequency Graticule	SHARP Frequency Multiply Factor	BROAD Frequency Multiply Factor
1	1.016	1.026
2	1.033	1.054
3	1.049	1.082
4	1.066	1.11
5	1.084	1.14
6	1.101	1.17
7	1.119	1.20
8	1.137	1.233
9	1.156	1.266
10	1.174	1.30
11	1.193	1.333
12	1.213	1.369
13	1.232	1.405
14	1.252	1.442
15	1.272	1.481

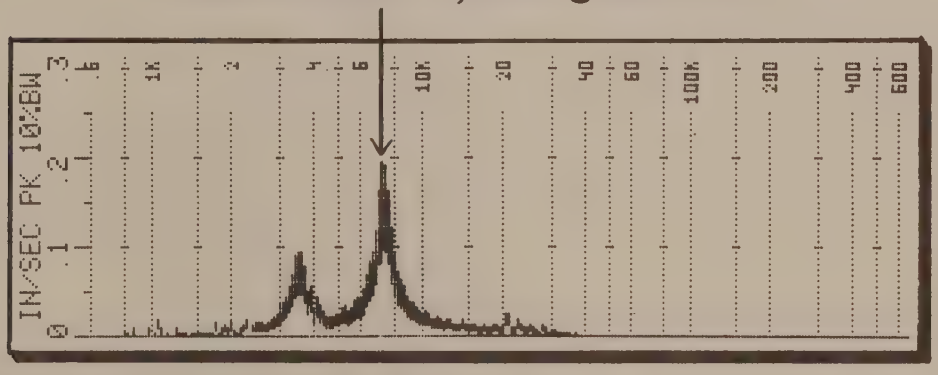
FREQUENCY

Frequency is read from the Frequency Scale across the top of the chart. If the highest frequency line is not located exactly on a measurement graticule, refer to the Calculation Table to determine the exact frequency.

- Count the number of lines the peak is above the nearest graticule.
- Find the correct multiplier in the "BROAD" or "SHARP" column of the chart.
- Multiply the number of lines times the multiplier.

For example, seven lines above the graticule in the "BROAD" position, multiplied by 1.2, gives a frequency of 7,200 CPM ± 2.5%. In the "SHARP" filter positions, the accuracy is ± 1.5%.

7 lines above 6,000 graticule



1.2 x 6,000 = 7,200 CPM ± 2.5%

To terminate a plot any time during the filter sweep:

- push the PLOT/ADV PAUSE switch to "PLOT", or
- alter any switch position.

To interrrupt a filter scan at any position along the frequency sweep:

- Push the PLOT ADV/PAUSE switch to "PAUSE".
- Press toward "PLOT" to resume the plot.

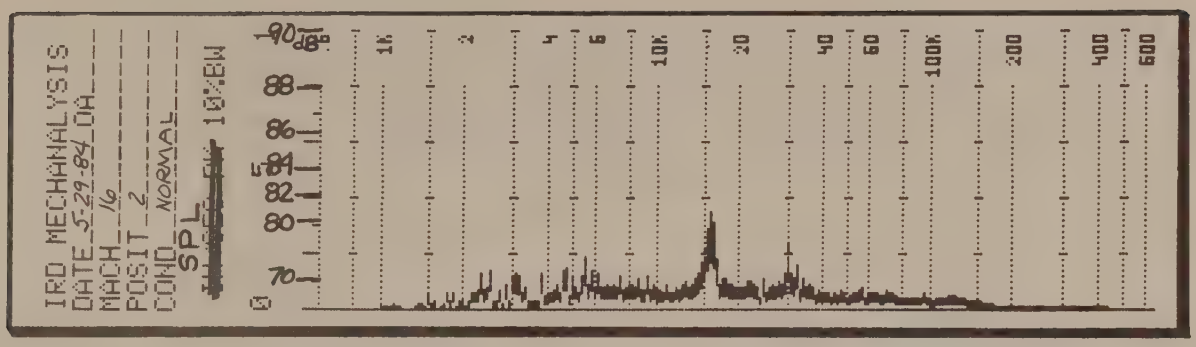
SOUND LEVEL vs. FREQUENCY PLOTS

The Model 820 can be used with the Model 308 Vibration/Sound Level Meter to measure and plot noise data in the same manner as vibration data. Follow these steps to obtain a Sound Level vs. Frequency Plot:

1. Attach the 544 pickup cable to the Model 308. Then connect to the input receptacle on the Model 820.
2. Set the Model 308 in the correct position for obtaining sound measurements, as listed in the Model 308 Instruction Manual.
3. Set these switches on the Model 308:
   - AMPLITUDE to "1".
   - UNITS to "VELOCITY".
   - FUNCTION to "BROAD" or "SHARP".
4. Adjust the Amplitude Selector on the Model 308 to obtain an amplitude reading between one-third of full scale and full scale. The Amplitude Meter on the Model 820 should indicate approximately the same reading as that on the Model 308.
5. Initiate the plot by pressing the PLOT ADV/PAUSE switch toward "PLOT".
6. On the printout, change IN/SEC to "SPL" (Sound Pressure Level) for future reference.
7. Correct the vertical amplitude scale. The Model 820 will print "0 to 1", but the actual noise level in decibels will depend on the amplitude range set on the Model 308.

   The top of the scale will be the amplitude range selected on the Model 308 plus 10 decibels. For example, if the Model 308 is set on 80 decibels, the full scale value on the Model 820 will be 90 decibels.

Linear Scale	Example	Equivalent
100% full scale	90 dB	0 dB
79% full scale	88 dB	- 2 dB
63% full scale	86 dB	- 4 dB
50% full scale	84 dB	- 6 dB
40% full scale	82 dB	- 8 dB
32% full scale	80 dB	-10 dB
10% full scale	70 dB	-20 dB

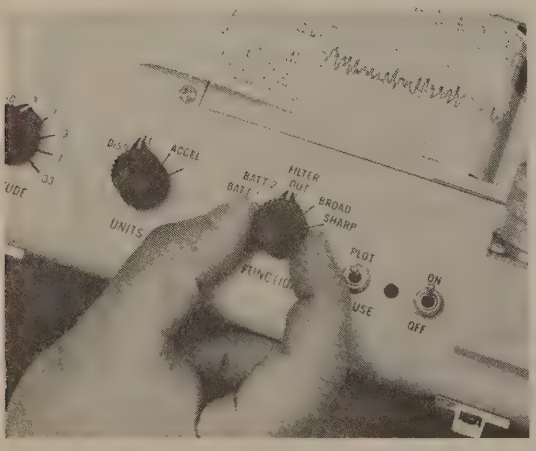


AMPLITUDE vs. TIME PLOTS

In the "FILTER OUT" mode the Model 820 will sample the overall amplitude at periodic intervals and plot the amplitude as a point on the chart each time a sample is taken.

The CHART SPEED switch, located under the chart paper cover, determines the sampling rate of Amplitude vs. Time plots.

- "SLOW" will obtain vibration trends over a period of thirty minutes or longer.
- "FAST" will record rapid vibration changes.
- "MEDIUM" records adequate details in a minimum amount of time.

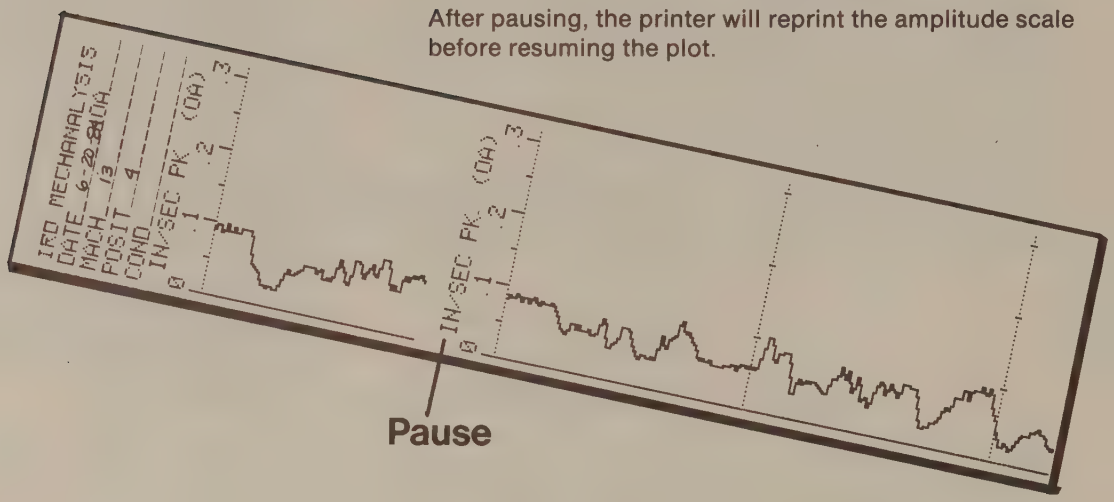


To obtain an Amplitude vs. Time Plot, follow these steps:

1. Connect the proper transducer and cable to the Model 820.
2. Attach the pickup to the machine being measured.
3. Set these switches on the Model 820:
   - FUNCTION to "FILTER OUT".
   - UNITS to "DISPLACEMENT, VELOCITY, ACCELERATION" or "SPIKE ENERGY".
   - AMPLITUDE between one-third of full scale and full scale.
4. Initiate the plot by pressing the PLOT ADV/PAUSE switch toward "PLOT".
5. To terminate the plot, press to "PLOT".

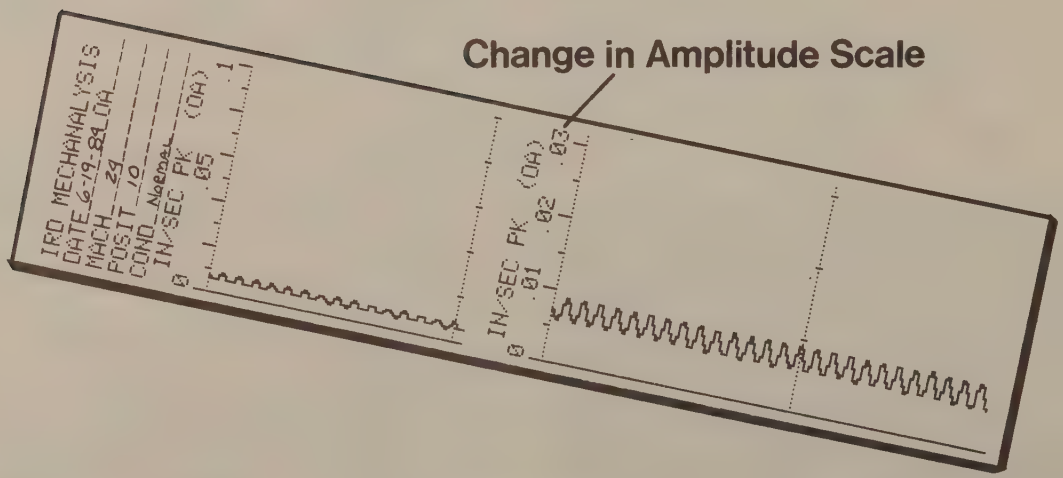
6. To pause during a plot, push the PLOT ADV/PAUSE switch toward "PAUSE". To restart, push to "PLOT".

   After pausing, the printer will reprint the amplitude scale before resuming the plot.



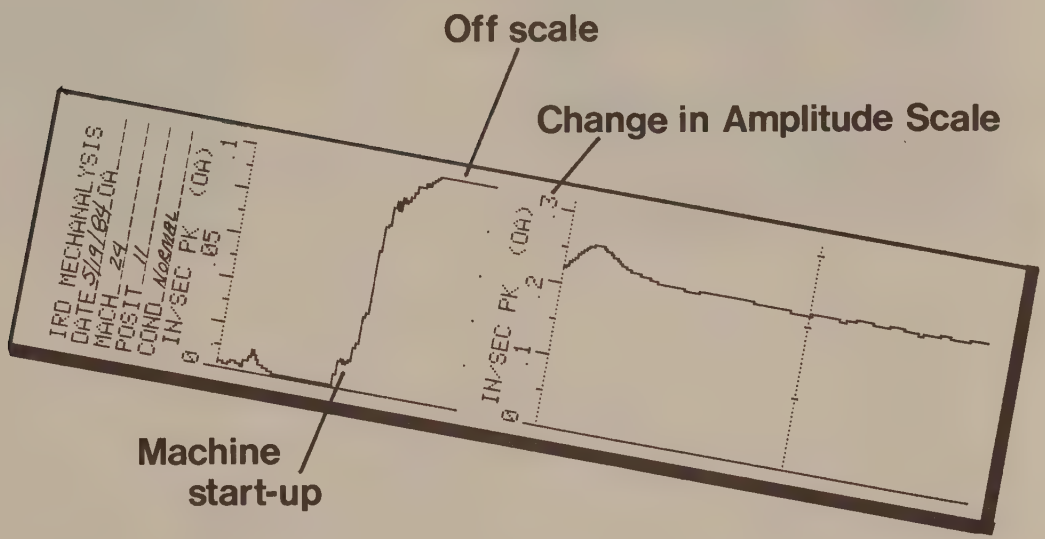
7. To change the amplitude scale during a plot, adjust the AMPLITUDE switch.

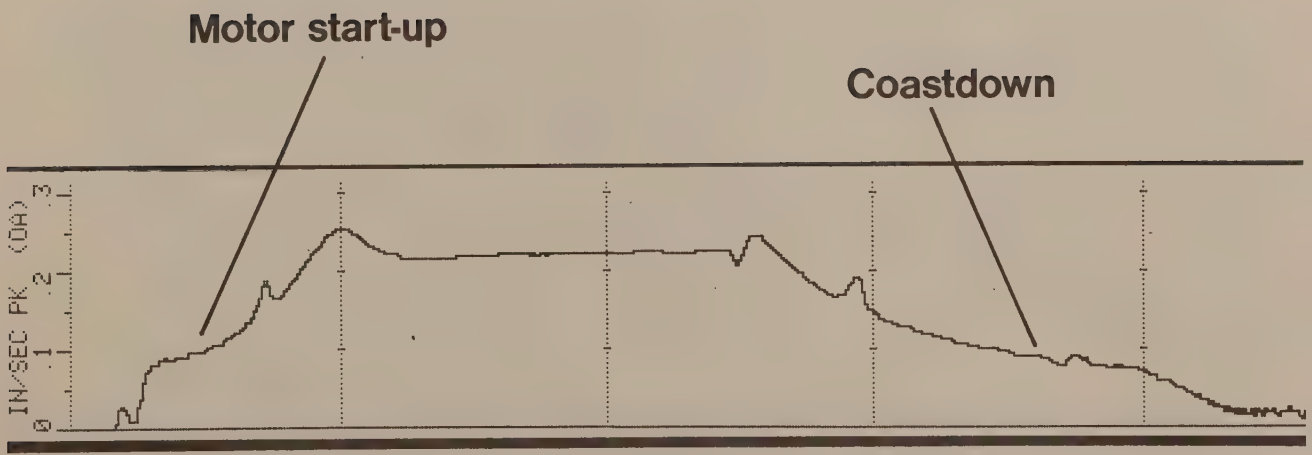
   After changing the scale, the printer will print out the new scale before resuming the plot.



NOTE: The capability of changing scales without terminating the plot is provided *only* in the "FILTER OUT" mode.

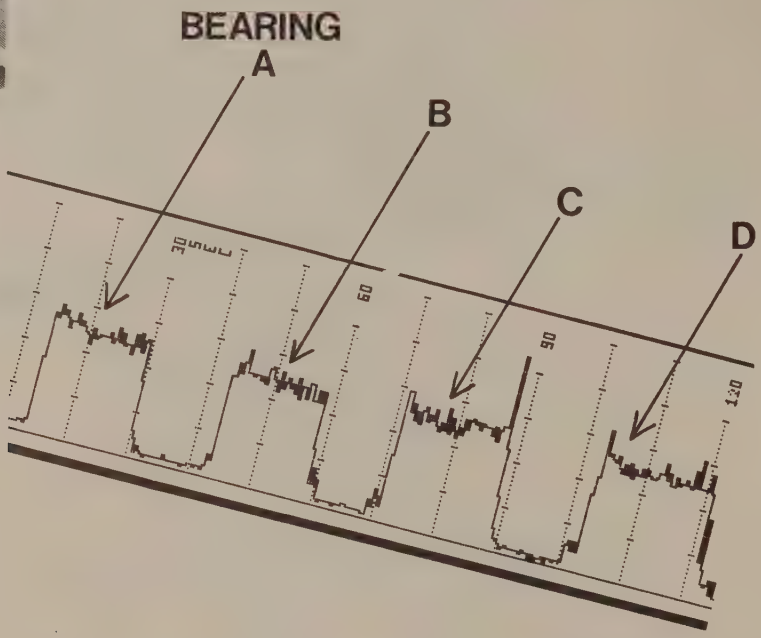
To obtain an Amplitude vs. Time Plot as a machine comes up to speed, select an amplitude range that allows for an on-scale reading from startup to full speed. However, if the signal does increase off the scale, adjust the AMPLITUDE switch.





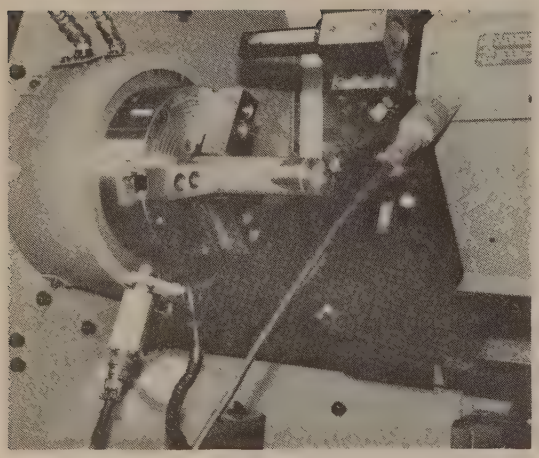
SPIKE ENERGY vs. TIME PLOTS

1. Initiate the plot by pushing the PLOT ADV/PAUSE switch toward "PLOT".
2. Hold the probe on each of the predetermined bearing positions.
   - Hold each position for approximately ten seconds. Wait about ten seconds between each measurement.
3. Identify each bearing on the printout.



SET UP FOR THE MODEL 820

	AMPLITUDE vs. FREQUENCY	AMPLITUDE vs. TIME
AMPLITUDE SWITCH	One-third to Full Scale	One-third to Full Scale
UNITS SWITCH	Velocity, or Acceleration	Velocity, Acceleration, or Spike Energy
FUNCTION SWITCH	Broad or Sharp	Filter Out

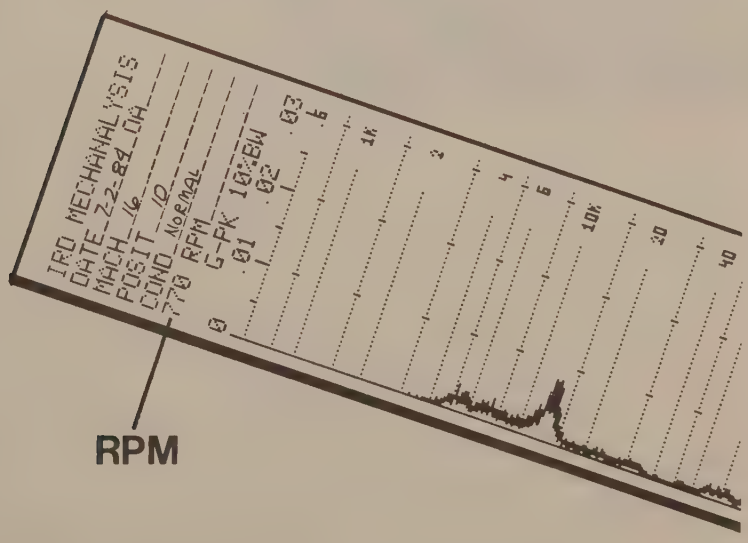


MACHINE RPM

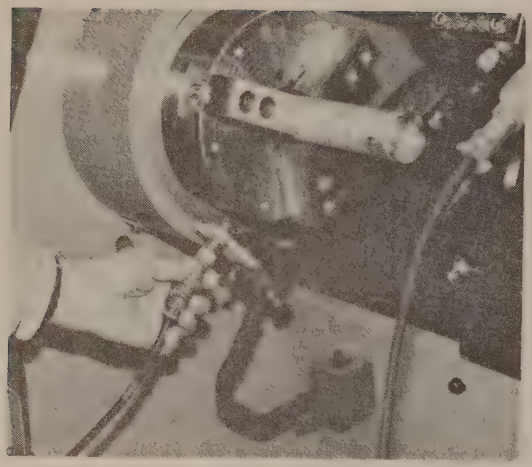
Used with a photoelectric or an electromagnetic pickup, the Model 820 prints RPM, rotating speed, of machines, Whenever a tachometer, either photoelectric or electromagnetic, is connected to the Model 820, the printer will give the machine RPM each time a plot is made.

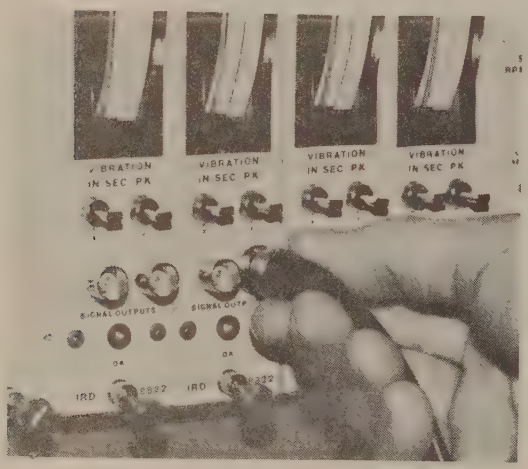
To use a Photoelectric Pickup:

1. Attach the photoelectric pickup to the appropriate cable and connect to the TACH/CHARGER INPUT on the Model 820.
2. Attach the photoelectric pickup to a universal mounting fixture or rigid bracket.
3. Place a strip of self-adhesive, reflective tape on the machine shaft, parallel to the shaft center line.
4. Position the pickup with the axis radial to the shaft, and the tip of the pickup ½ inch to 6 inches from the shaft.
5. Check the setup by rotating the shaft until the tape is directly under the light beam. The red LED on the photocell should go out. If not, move the pickup closer to the shaft.
6. Set up the Model 820 for either an Amplitude vs. Frequency or an Amplitude vs. Time plot.
7. Initiate the plot by pressing the PLOT ADV/PAUSE switch toward "PLOT".



The Model 820 will print out the plot heading, as well as the RPM of the machine, before printing the requested plot.





To use an Electromagnetic Pickup:

1. Attach the electromagnetic pickup to the appropriate cable and connect to the TACH/CHARGER INPUT on the Model 820.
2. Attach the electromagnetic pickup to a universal mounting fixture.
3. Position the fixture with the pickup axis radial to the shaft, and the tip of the pickup within .13 to .51 millimeters.
4. Locate the pickup on a sharp edge protrusion or depression. For example, a keyway, hole, or bolt head.
5. Set up the Model 820 for either an Amplitude vs. Frequency or an Amplitude vs. Time plot.
6. Initiate the plot by pressing the PLOT ADV/PAUSE switch toward "PLOT".

The Model 820 can obtain vibration signatures from any non-contact pickup system having a 200 millivolt sensitivity, or from vibration monitors in control rooms. Using the correct pickup cable, as listed in the Operators Manual, connect the Model 820 to the output jack of the monitor, or attach directly to the signal sensor.

For additional information about the operation of the IRD Model 820, or for on-site assistance, contact the IRD Mechanalysis world-wide consulting service.

Part 1: Exercises

Circle the letter or letters of the correct responses.

1. The Model 820 is a portable, microprocessor-controlled unit, designed to:
   a. acquire amplitude vs. frequency vibration plots.
   b. provide fast, narrow-band vibration analysis of all types of rotating equipment.
   c. detect the rotating speed of machines.
   d. All of the above.

2. The Model 820 can provide:
   a. Amplitude vs. Frequency Plots.
   b. Amplitude vs. Time Plots.
   c. Spike Energy vs. Time Plots.
   d. RPM printouts.

3. The Amplitude Meter displays:
   a. battery condition.
   b. overall vibration level.
   c. units of measurement.
   d. RPM values.

4. The "BROAD" position gives a filter bandwidth of:
   a. 0 to 1.
   b. 5%.
   c. 10%.
   d. 3 to .3.

5. If the Model 820 is set up for an Amplitude vs. Frequency Plot, pressing the PLOT ADV/PAUSE switch to "PLOT" *twice* will cover the _____ frequency range.
   a. 60,000 to 600,000 CPM.
   b. 180 to 600,000 CPM.
   c. 600 to 600,000 CPM.
   d. 6,000 to 600,000 CPM.

6. A speed reference pickup may be attached to the _____ on the Model 820 to provide a RPM printout.
   a. INPUT RECEPTACLE.
   b. TACH/CHARGER INPUT.
   c. 970 Accelerometer.
   d. Both A and B.

7. A fully-charged battery pack will operate for approximately _____ hours.
   a. 6.
   b. 24.
   c. 10.
   d. 48.

8. The standard pickup supplied with the Model 820 is:
   a. 970 Accelerometer.
   b. 544 Velocity Pickup.
   c. Non-contact Pickup.
   d. Model 308 Sound Meter.

9. The IRD Calibrator is used to check the _____ modes of the Model 820.
   a. Displacement and Velocity.
   b. Spike Energy.
   c. Displacement, Velocity and Acceleration.
   d. Velocity and Acceleration.

10. The blinking red LED on the top of the Model 820 indicates:
    a. the power is on.
    b. the chart paper is running low.
    c. the batteries are low.
    d. the microprocessor is not operating.

11. To print a vibration signature of the TEST SIGNAL, set the UNITS switch at:
    a. Displacement.
    b. Velocity.
    c. Acceleration.
    d. A, B, or C.

12. The CHART SPEED switch is located:
    a. in the battery compartment.
    b. under the chart paper cover.
    c. in the lid.
    d. beside the fuses.

13. Printouts generated by the Model 820 show:
    a. bandwidth and engineering units.
    b. amplitude and frequency scales.
    c. machine notes and date.
    d. All of the above.

14. Pushing the PLOT ADV/PAUSE switch toward "PLOT" during any plot already in progress will:
    a. pause the plot.
    b. terminate the plot.
    c. repeat the plot heading.
    d. change the amplitude scale.

15. List the vibration parameters that can be measured with the Model 820:
    a. _____
    b. _____
    c. _____
    d. _____

Part 1: Hands-On Exercises

Review the features of the Model 820 and conduct the testing sequence.

1. Open the Model 820 and remove the lid.
2. Connect the 970 Accelerometer to the cable and attach to the INPUT RECEPTACLE.
3. Locate these features on the Model 820:
   - Amplitude Meter
   - AMPLITUDE SWITCH
   - UNITS SWITCH
   - FUNCTION SWITCH
   - PLOT ADV/PAUSE SWITCH
   - PRINTER
   - TACH/CHARGER INPUT
4. Turn "on" the power.
5. Check for the "TEST OK" printout.
6. Observe the LED. It should stay on for 6 seconds and then start blinking.
7. Check the batteries:
   - Set the FUNCTION to "BATT 1".
   - Read the Amplitude Meter. The needle should register near "HI-1".
   - Set the FUNCTION to "BATT 2".
   - Read the Amplitude Meter. The needle should register near "HI-2".
   - If necessary, recharge the batteries or replace the battery pack.
8. Print a TEST SIGNAL:
   - Set AMPLITUDE to "TEST".
   - Set UNITS to "DISPLACEMENT, VELOCITY, or ACCELERATION".
   - Set FUNCTION to "BROAD".
   - Read the Amplitude Meter. The needle should register between .75 and .85.
   - Press the PLOT ADV/PAUSE SWITCH toward "PLOT" to initiate the plot.
9. Check the finished plot with the example in this workbook.
10. (Optional) Print a TEST SIGNAL in the "SHARP" mode.
11. When finished using the Model 820, connect the battery charger.

Part 2: Exercises

Circle the letter or letters of the correct responses.

1. To obtain an Amplitude vs. Frequency Plot:
   a. use a magnetic holder.
   b. use a 9-inch probe.
   c. attach with a ¼-28 stud.
   d. attach to a monitor.

2. An Amplitude vs. Frequency Plot cannot be obtained in the _____ mode.
   a. Displacement.
   b. Velocity.
   c. Acceleration.
   d. Spike Energy.

3. Generally, the AMPLITUDE switch should be adjusted to register:
   a. Between 1/3 of full scale and full scale.
   b. Above 60%.
   c. Below 25%.
   d. At the mid-point.

4. An Amplitude vs. Frequency Plot in the "SHARP" mode is obtained:
   a. faster than in "BROAD".
   b. slower than in "BROAD".
   c. in the same amount of time as in "BROAD".

5. To determine the amplitude of an over-scale peak, multiply the amplitude of the low end of the peak by:
   a. 60%.
   b. 2.
   c. 1/3.
   d. Over-scale amplitudes cannot be determined.

6. To resume an interrupted plot, press the PLOT ADV/PAUSE switch toward:
   a. PLOT.
   b. ADV/PAUSE.
   c. ON.
   d. VELOCITY.

7. To determine the exact frequency of a peak not on a measurement graticule, count the number of lines _____ and multiply by the amount shown in the Calculation Table.
   a. below the frequncy graticule.
   b. above the amplitude graticule.
   c. above the frequency graticule.
   d. below the amplitude graticule.

8. _____ cannot be obtained with a 544 Velocity Pickup.
   a. Velocity.
   b. Acceleration and Displacement.
   c. Spike Energy.
   d. Acceleration.

9. _____ cannot be obtained with a 970 Accelerometer.
   a. Displacement.
   b. Acceleration and Displacement.
   c. Spike Energy.
   d. Velocity.

10. A vibration signature cannot be generated in the _____ mode.
    a. Battery.
    b. Spike Energy.
    c. Acceleration.
    d. Velocity.

11. To obtain noise data with the Model 308, connect a Model 308 Vibration/Sound Level Meter and a:
    a. magnetic pickup.
    b. 970 Accelerometer.
    c. 544 Velocity Pickup Cable.
    d. A, B, or C.

12. Change the amplitude scale on the printouts of Sound Level vs. Frequency to:
    a. g.
    b. gSE.
    c. IN/SEC.
    d. SPL.

13. The top of the scale on a Sound Level vs. Frequency Plot will be equal to the selected range on the Model 308 plus:
    a. 100 decibels.
    b. 1 decibel.
    c. 10 decibels.
    d. 90 decibels.

14. To obtain an Amplitude vs. Time Plot, the FUNCTION switch must be set to:
    a. BROAD.
    b. SHARP.
    c. VELOCITY.
    d. FILTER OUT.

15. An Amplitude vs. Time Plot can be obtained in any of the 820 measurement units.
    a. True.
    b. False.

16. Changing the amplitude scale during an Amplitude vs. Time Plot will terminate the plot.
    a. True.
    b. False.

17. To obtain a Spike Energy vs. Time Plot, attach:
    a. a 544 Velocity Pickup.
    b. a 970 Accelerometer and a 9-inch probe.
    c. a 544 Velocity Pickup and a magnetic holder.
    d. a 308 Sound Level Meter.

18. Photoelectric and electromagnetic pickups obtain:
    a. sound levels of machines.
    b. vibration levels on rolling bearings.
    c. rotating speeds of machines.
    d. A and C.

19. An electromagnetic pickup is smaller and must be placed closer to the shaft than a photoelectric pickup.
    a. True.
    b. False.

20. If a photoelectric or electromagnetic pickup is attached to the Model 820, the printer will indicate the machine RPM each time a plot is made.
    a. True.
    b. False.

Part 2: Hands-On Exercises

Set up the Model 820 and perform the following operations.

Obtain an Amplitude vs. Frequency Plot:

1. Connect a magnetic holder, the 970 Accelerometer, and cable to the Model 820.
2. Attach the pickup to a measurement position on a machine.
3. Set UNITS to "VELOCITY or ACCELERATION."
4. Set FUNCTION to "BROAD or SHARP".
5. Adjust AMPLITUDE until needle registers between 1/3 of full scale and full scale.
6. Press PLOT ADV/PAUSE switch toward "PLOT" to initiate the plot.

7. Check the printed plot. It should cover the frequency range from 600 to 600,000 CPM.
8. Repeat this procedure at another position on the machine. Press the PLOT ADV/PAUSE switch **twice** to initiate the plot.
9. During the second plot, press the PLOT ADV/PAUSE switch toward "PAUSE." To resume, press toward "PLOT" again.
10. Check the printed plot. It should cover the frequency range of 6,000 to 600,000 CPM.
11. Perform a third Amplitude vs. Frequency Plot, pressing the PLOT ADV/PAUSE switch **three** times. Set the AMPLITUDE switch so the highest peak will print over-scale.
12. Check the printed plot. It should cover the frequency range from 60,000 to 600,000 CPM. Also, determine the amplitude of the over-scale peak.

Obtain an Amplitude vs. Time Plot:

1. Connect a transducer and cable to the Model 820.
2. Attach the pickup to a measurement position on a machine.
3. Set these switches:
   - FUNCTION to "FILTER OUT".
   - UNITS to "DISPLACEMENT, VELOCITY, ACCELERATION or SPIKE ENERGY."
   - AMPLITUDE between 1/3 full scale and full scale.
4. Initiate the plot by pressing the PLOT ADV/PAUSE switch as many times as desired.
5. During the plot, press the PLOT ADV/PAUSE switch toward "PAUSE." To resume the plot, press toward "PLOT". Notice how the printer repeated the amplitude scale before continuing.
6. When you've plotted enough information, press toward "PLOT" to terminate the signature.
7. Check the printed plot.
8. Obtain another Amplitude vs. Time Plot as a machine comes up to speed.
9. During this plot, change the amplitude scale. Notice how the printer interrupts the plot, prints the new amplitude scale, and then resumes the plot.
10. Continue the plot as you turn off the machine and record the coastdown. Then terminate the plot.

Obtain a Spike Energy vs. Time Plot:

1. Attach the 970 Accelerometer, cable, and a 9-inch probe to the Model 820.
2. Set up the Model 820 in the same manner as for other Time Plots.
3. Initiate the plot by pressing the PLOT ADV/PAUSE switch toward "PLOT."
4. In sequence, hold the probe on each of the bearings for approximately ten seconds and wait about ten seconds between each measurement.
5. Terminate the plot. Identify each bearing on the printout.

Obtain a Sound Level vs. Frequency Plot: (Optional)

1. Connect a Model 308 Vibration/Sound Level Meter and a 544 Velocity Pickup Cable to the Model 820.
2. Set these switches on the Model 820:
   - AMPLITUDE to "1".
   - UNITS to "VELOCITY".
   - FUNCTION at "BROAD or SHARP".
3. Set the Model 308 as directed in the Model 308 Instruction Manual.
4. Initiate the plot by pressing the PLOT ADV/PAUSE switch toward "PLOT".
5. Check the printout. Change IN/SEC to "SPL". Correct the vertical amplitude scale.

Use a Photoelectric or Electromagnetic Pickup to determine a machine's rotating speed. (Optional)

1. Using the appropriate pickup and cable, connect them to the TACH/CHARGER INPUT on the Model 820.
2. Attach the pickup to a mounting fixture or rigid bracket.
3. Position the pickup with the axis radial to the shaft at the appropriate distance.
4. Set up the Model 820 for either an Amplitude vs. Frequency or an Amplitude vs. Time Plot.
5. Initiate the plot.
6. Check the RPM value printed on the plot heading.

Repeat these exercises as necessary, until you become familiar with the procedures.

Answer Key

Part 1

1. d
2. a, b, c, d
3. a, b
4. c
5. d
6. b
7. c
8. a
9. d
10. a
11. d
12. b
13. d
14. b
15. Displacement
    Velocity
    Acceleration
    Spike Energy

Part 2

1. a, b, c, d
2. d
3. a
4. b
5. b
6. a
7. c
8. d
9. a
10. a, b
11. c
12. d
13. c
14. d
15. a
16. b
17. b
18. c
19. a
20. a